Data Centers and Energy Use – Lets's Look at the Data

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Data Center Market

- Communications and the Internet
- Integral Part of Many industries
- Key to Research and Other Institutions

Why Benchmark Data Centers?

- The "market" is large and growing
- Many myths exist concerning electrical loads
- Utility requests for power were unrealistic
- Data centers are energy intensive
  - 24 hour a day operation
  - Large base load
  - Unknown efficiency improvement opportunity
- Energy Intensities are reputedly rising

April 10, 2003 San Jose Mercury News

"A new power plant is up and running in San Jose's Alviso neighborhood, but the massive Internet server farm that it was supposed to fuel is nowhere in sight.

The Los Esteros Critical Energy Facility, a 180-megawatt plant built by Calpine in North San Jose, was designed to power an adjacent Internet server farm by U.S. Dataport. The server farm never broke ground -- and company officials didn't return calls Wednesday to say if or when it might -- but Calpine proceeded with the plant anyway, after securing a three-year deal with the state Department of Water Resources to buy power.

Company and state officials say the plant is still needed, even though the state's infamous energy crunch of 2000-01 is long over."

180 MW: 900,000 sq.ft. x 200 W/sq.ft

Data Center Metrics

- IT Equipment Load Intensity – W/sq.ft.
- Infrastructure Load Intensity – W/sq.ft.
- Chilled Water Plant – kW/Ton
- Computer Room Air Conditioners – cfm/kW
- Central air handler(s) – cfm/kW
- Annual energy cost - $/sf
- Annual energy use – kWh/sf/yr

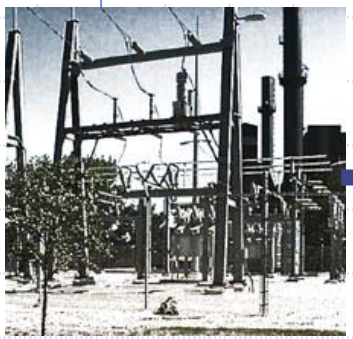
Central Plant metrics

- Chiller efficiency – kW/ton
- Cooling tower efficiency – kW/ton
- Condenser water pump efficiency – kW/ton
- Chilled water pump efficiency – kW/ton
- Hot water pump efficiency – kW/ton

Electricity Flows in Data Centers

HVAC system

local distribution lines



lights, office space, etc.

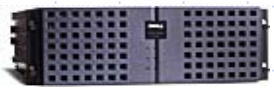
uninterruptible load

to the building, 480 V

UPS

PDU

computer racks



computer equipment

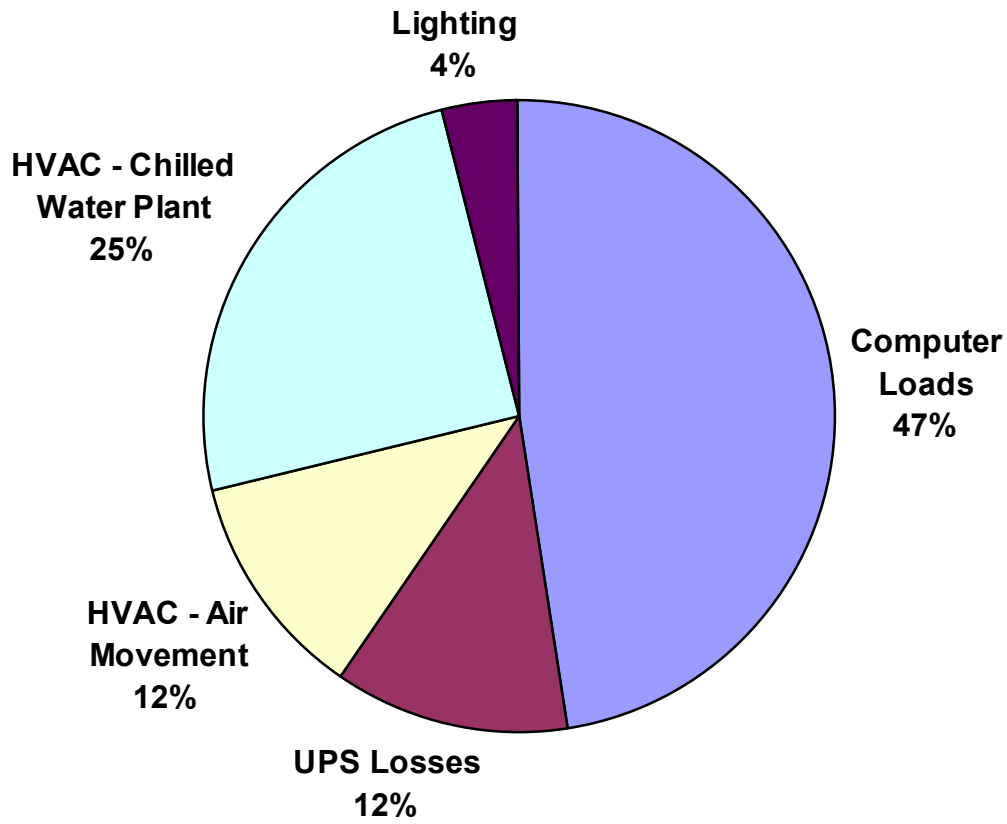
backup diesel generators

UPS = Uninterruptible Power Supply

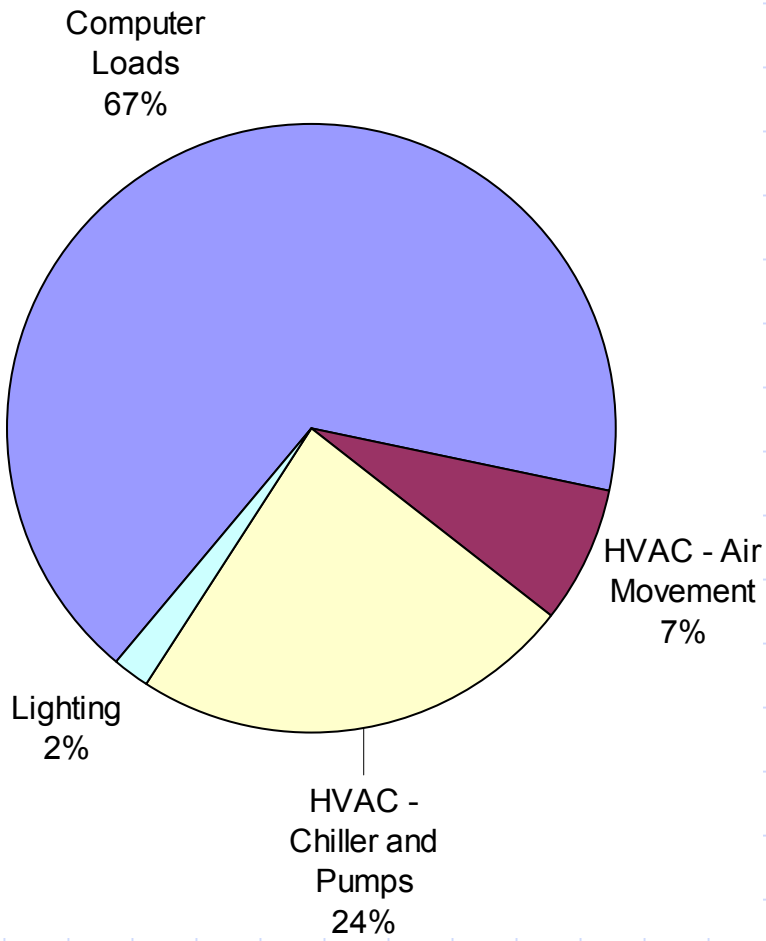
PDU = Power Distribution Unit;

We also operate a data center …

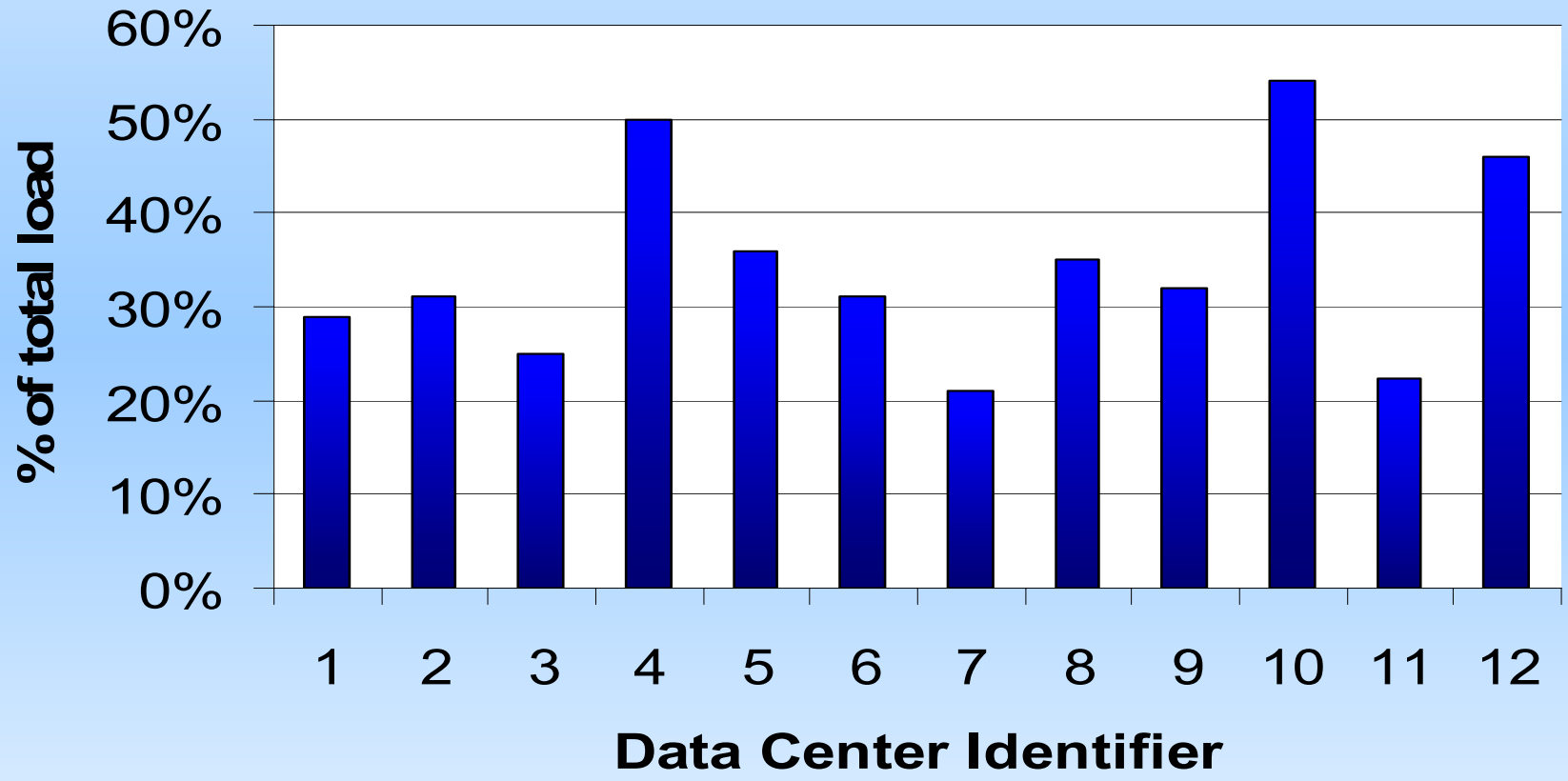
Data Center Energy End-Use Breakdown



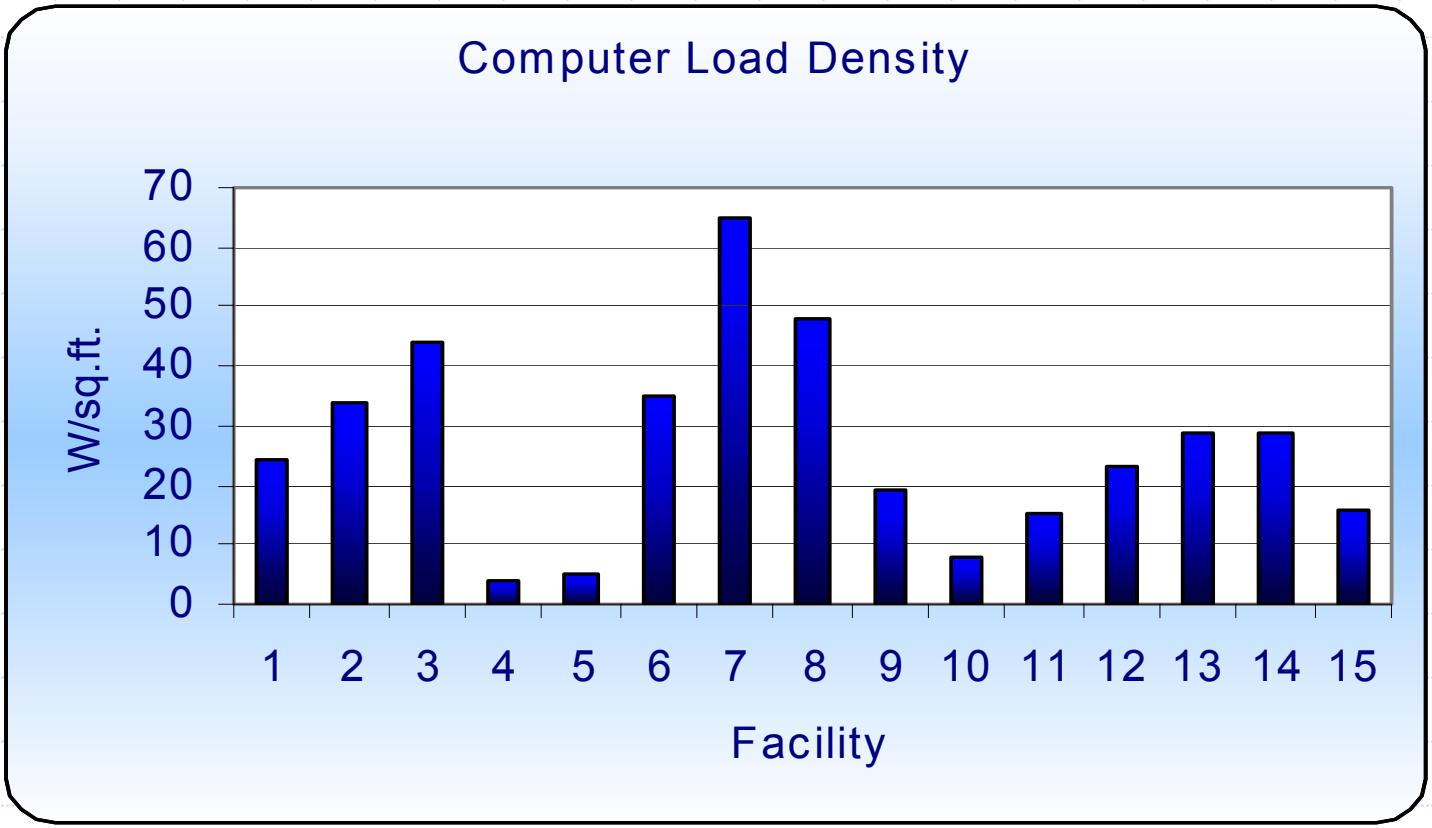
Better Ratio



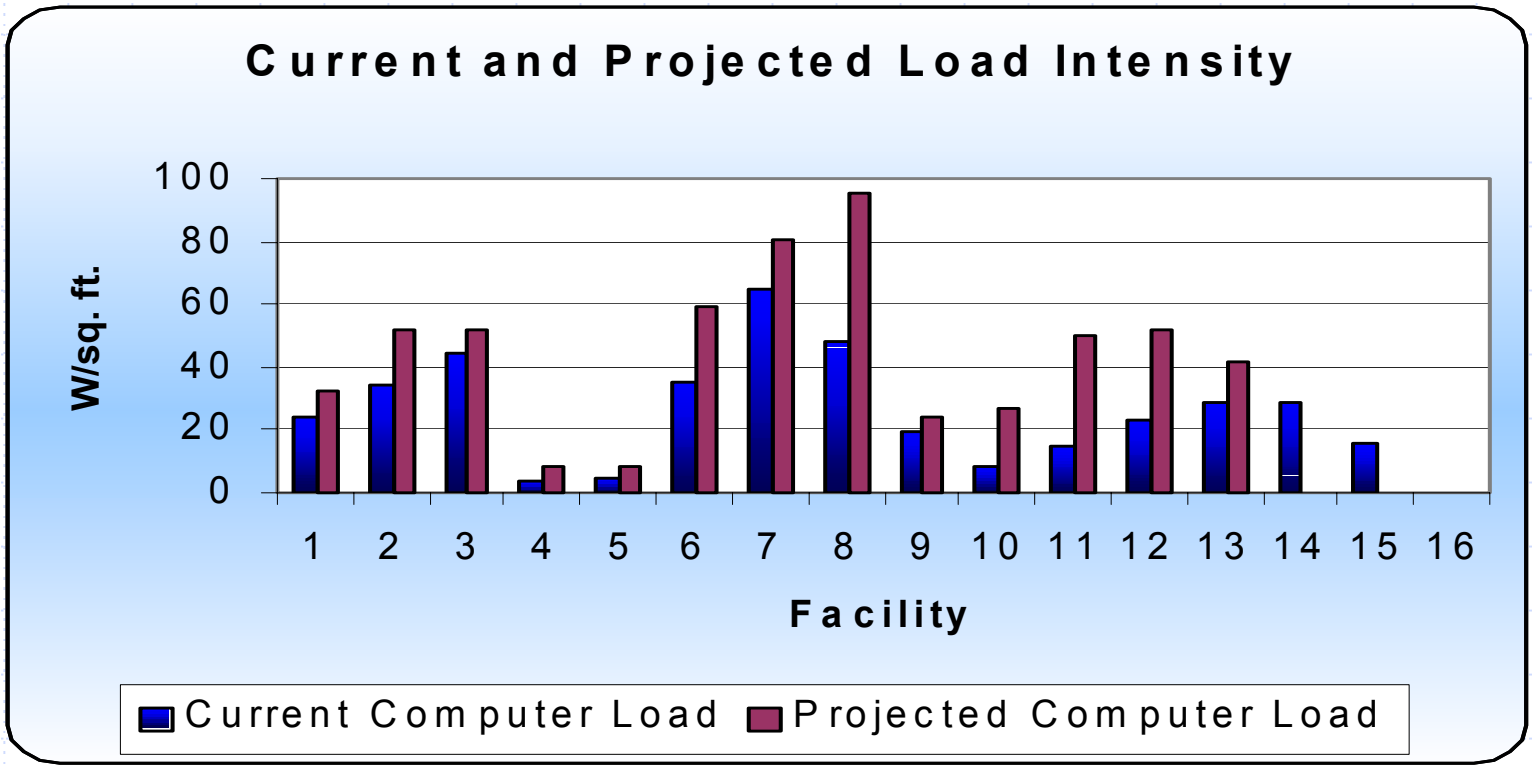
HVAC (as a % of total load)



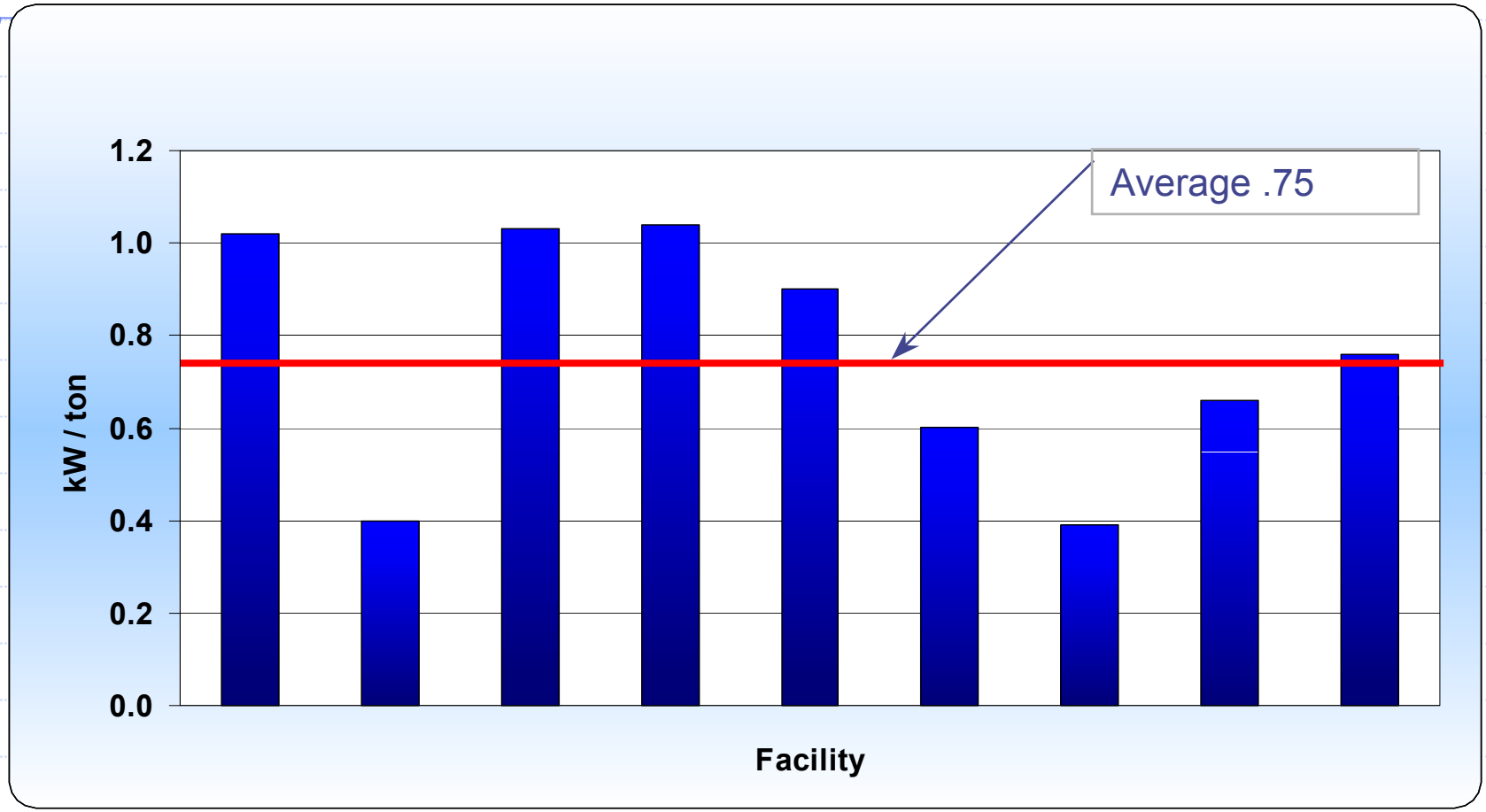
Benchmarking Computer Loads



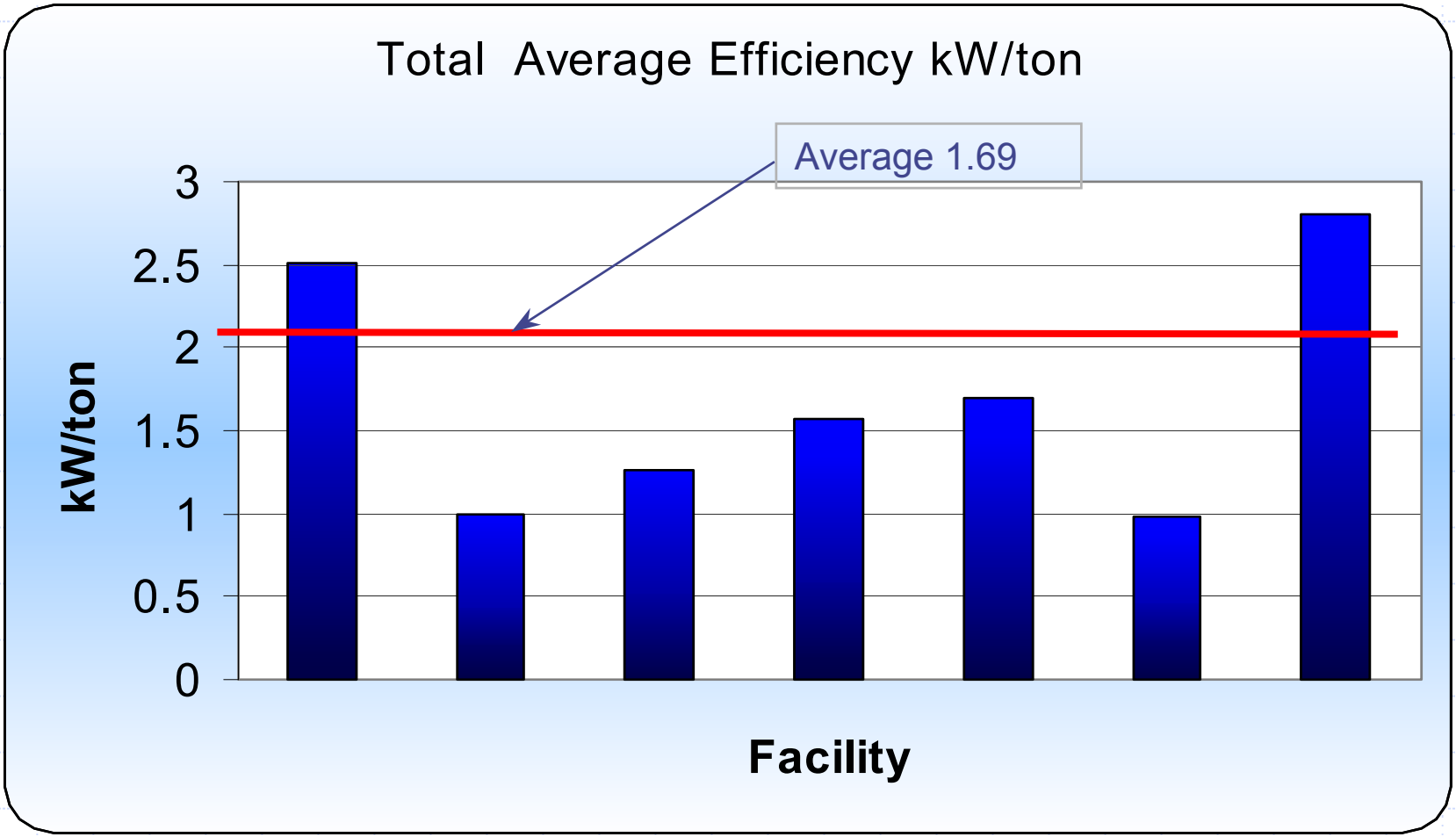
Projecting Computing Load When Fully Loaded

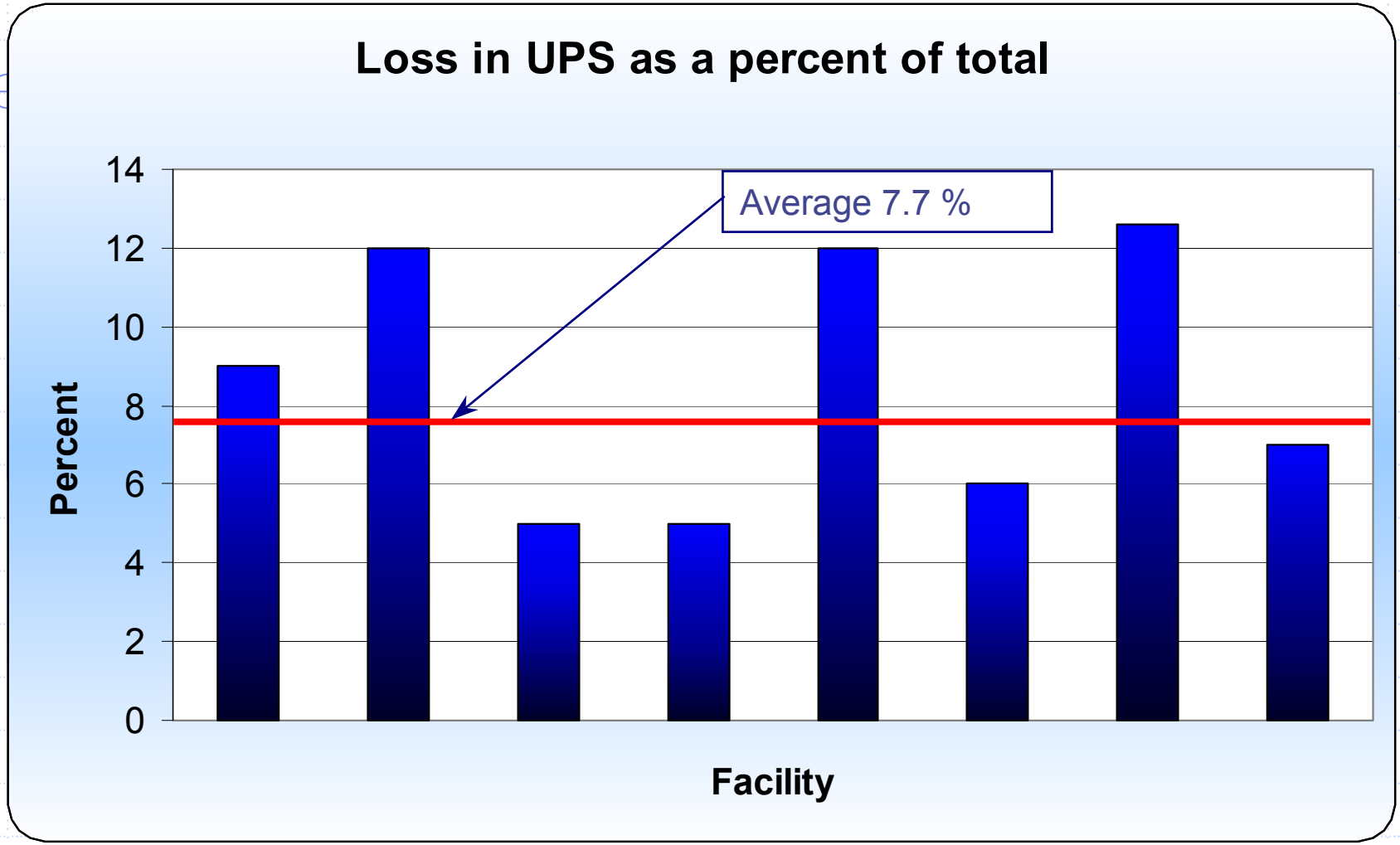


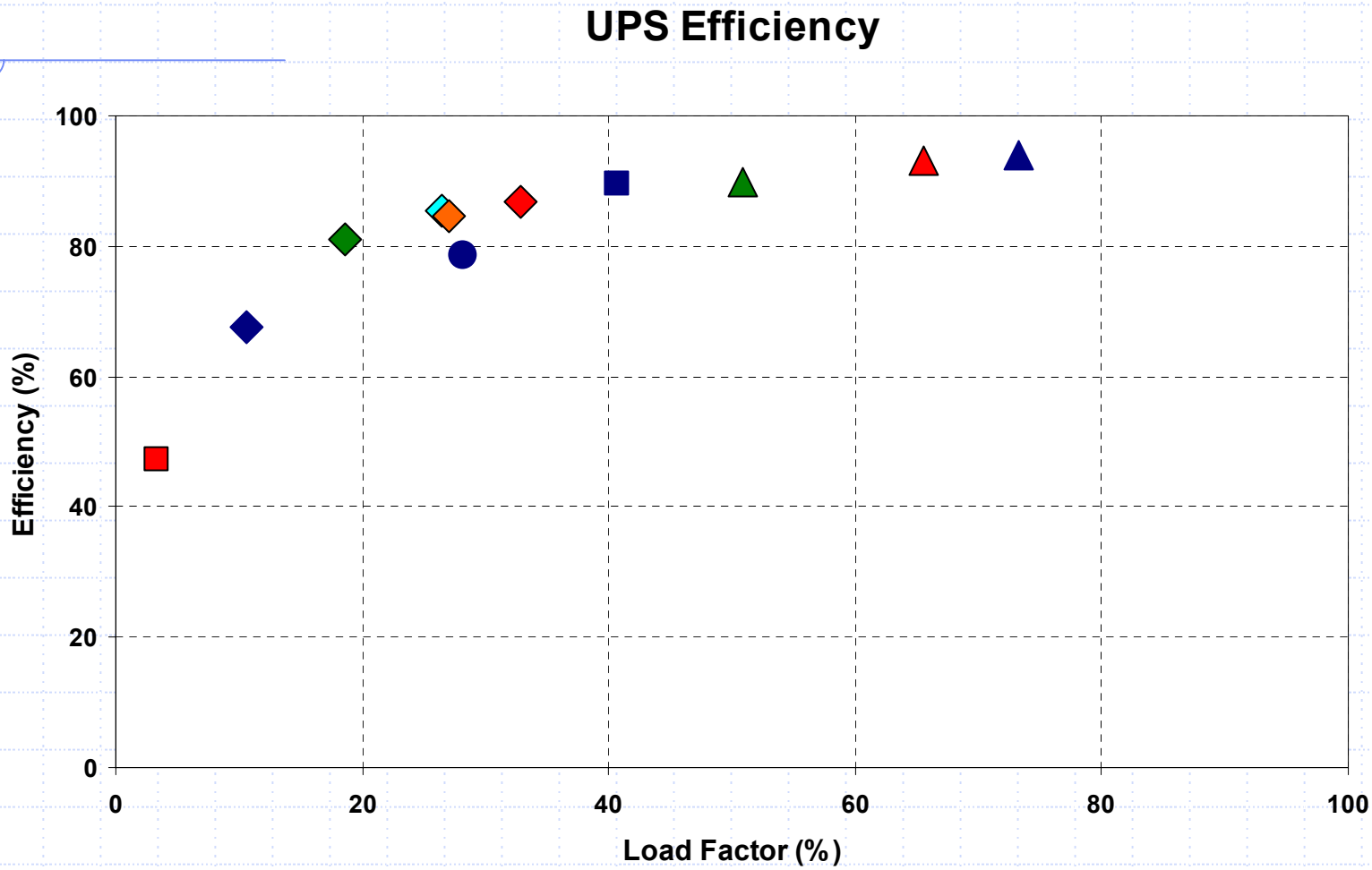
Chiller Comparison



Total Chilled Water System Efficiency




Loss in UPS as a percent of total
Average 7.7 %
Percent
14
12
10
8
6
4
2
0
Facility


UPS Efficiency
Efficiency (%)
100
80
60
40
20
0
0
20
40
60
80
100
Load Factor (%)

Index of Performance

The Uptime Institute proposes a metric termed:

Index of Performance = Building systems KW ÷ UPS Output

Possible Additional Benchmarks

- Computations per Watt
- Nameplate vs. Actual Comparisons
  - IT Equipment
  - UPS
  - Chillers
  - Transformers
- Standby generator energy losses
- Others?

General Recommendations

- Benchmark to Know Where You Stand
- Life Cycle Cost Analysis
- Partnership with IT Professionals
- Evaluate Load Spreading vs. Compaction

Energy Efficiency Recommendations

- Match Systems to Real Loads
  - Efficient Operation at Part Loads
  - Ability to Add Load
  - Modular Design
- Use of Free Cooling
  - Plate/Frame Heat Exchanger
  - Cooling Towers
  - Air Side Economizers
- Avoid simultaneous humidifying and dehumidifying

Best Practices

- Benchmarking can identify best practices:
  - Use of free cooling
  - Separate high temperature chiller
  - Use of multiple cooling towers
  - Reduce excess pumping
  - Recirculation air setback
- Benchmarking can identify maintenance problems

More Efficiency Recommendations

Air Cooling

- Air Handler Efficiency
- Take Advantage of Thermal Stratification
- Air Management
  - Hot/Cold Aisles
  - Seal Openings
  - Temperature and Humidity

Efficient Reliability

- UPS systems
  - Configure to Operate Near Rated Load
  - Compare System Efficiencies at Expected Operation
  - Inertial vs. Battery Systems
- Standby Generator Losses

Ideas for the Future

- Minimize Power Conversions
- Eliminate Individual Power Supplies
- Eliminate Individual Fans
- On-Site Generation (DC) with Grid Back-up

Data Center websites

- http://Datacenters.lbl.gov
- www.upsite.com
- www.7X24exchange.org
- www.itherm.org
- http://www.me.gatech.edu/me/publicat/brochures/Mettl/Bro0302.htm